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EFFECT OF FIRE IN TORNDIRRUP NATIONAL PARK, SOUTH COAST, WESTERN AUSTRALIA

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ABSTRACT

A wildfire in 1997 burnt the central part of the Torndirrup National Park on the south coast of Western Australia. An existing fauna survey within the burnt area was extended to cover a four-year period after the fire, to study recolonisation by animals and regeneration of plants. One predominant banksia, the winter-flowering *Banksia quercifolia*, was mostly destroyed by the fire but regenerated from seed. The absence of its flowers in winter affected the numbers of the dependant Honey Possum at that time of year.

INTRODUCTION

Torndirrup National Park is situated on the south coast of Western Australia, south of Albany, and is predominantly banksia heath and woodland with a dense understorey of sword grass, *Lepidosperma* species. No permanent surface water exists during summer.

A survey of the terrestrial vertebrate fauna was carried out in the mid-1980s, using pitfall traps and Elliott traps (Smith 1990). This established that there was a rich fauna of small vertebrate species within the Park, including six small mammal species, five species of frogs and twenty species of reptiles. Amongst the mammals, the Honey Possum *Tarsipes rostratus* was particularly common, but also recorded were the Dibbler *Parantechinus apicalis*,

which had not been trapped since 1988, and the Mardo *Antechinus flavipes*.

Within the central heath-lands of the Park, the Oak-leafed Banksia *Banksia quercifolia* was the dominant banksia, providing not only food but also shelter for the many Honey Possums found in this banksia heath during winter (Smith 1991). Small sparse stands of Candle Banksia *Banksia attenuata* also occurred in the central third. Annual monitoring of the *Tarsipes* population, using the original pitfall traps, revealed that their numbers remained relatively constant over a ten-year period, as if they had established a climax.

Prior to a wildfire in January 1997, the heath lands had not been burnt for nearly thirty years. The last fire was recorded in 1969, the year the Park was declared. Thus the *B. quercifolia* were mature, with very few seedlings providing evidence of regeneration from seed. Dieback (*Phytophthora* infections) is present in the Park.

THE 1997 FIRE

The midsummer fire on 17 January 1997 initially burnt fiercely uphill, fanned by an east wind, and burnt 610 hectares of the northern centre of the Park, an estimated quarter of this area being granite outcrops (monadnocks) on which some animals may have survived the fierce radiant heat in crevices. The fire effectively destroyed most (>95%) of the old *B. quercifolia* plants in the Park and greatly altered the vegetation structure. Within the main trapping area, three counts of dead *B. quercifolia* plants revealed an average density of 150 plants per hectare in the deep sandy soils on which they grew best. Two days after the fire, gale-force winds dispersed the ash-beds so that in many areas only bare sand remained. Ten millimetres of rain fell on the third day. Devastating as the 1997 fire was, it provided an opportunity to study recolonization and regeneration of an area for which fauna records were available over the previous ten years. Friend (1993) reviewed the impact of fire on small vertebrates in woodlands and heathlands of temperate Australia, but with only one reference to Western Australia. Bamford (1986) conducted his work in *Banksia* woodland north of Perth but has described the responses of frogs and reptiles to fire in the same area (Bamford 1992; 1995).

METHODS

Vertebrate fauna were surveyed following the methods described for the original survey (Smith 1990). Four original sites (A, E, G, H) were on a north-facing slope, in sand, with 60 cm deep pitfall traps spaced at approximately 10 metres in lines. To these four was added Site J in April 1988. The

Table 1. Showing features of trapsites A, E, G, H and J.

Site	Number of pitfalls	Drift Fence	Distance from fire edge in metres	Predominant banksia	
				Banksia quercifolia	*Banksia attenuata*
A	6	No	<100		+
E	13	Partly	400		+
G	9	No	400	+	
H	10	Yes	300	+	
J	9	Yes	600	+	

features of each site are summarised in Table 1. They were all affected by the 1997 fire. The plastic tops of the 60 cm deep pitfall traps melted and the drift fences were totally destroyed. By trimming off the melted top 2 to 5 cm of each trap *in situ* with an angle grinder, they were restored to full use again, though fractionally shorter, averaging 55 cm in depth. Drift fences were replaced. By April 1997 the monitoring was resumed, using these same sites and traps.

During the annual monitoring prior to the fire, traps were opened for a few days every four to six weeks, but for longer periods during the last quarter of each year (spring into summer), when more captures were generally recorded (See Table 2). To facilitate comparison of the data pre- and post-fire, where there is a normal seasonal bias, captures have been totaled quarterly (First quarter; January to March) for each year. Since the initial survey (Smith 1990), captures during the annual monitoring have been relatively constant, so four years before and after the fire, covering the period 1993 to 2000, have been considered adequate for comparison. For *Tarsipes* only, capture rates have been calculated and adjusted per 1000 trapnights, and the capture rates

Table 2. Total number of trapnights for sites A,E,G,H and J combined for each quarter for the years 1993–2000. Note the date of the fire.

YEAR	QUARTER				TOTAL
	1	2	3	4	
1993	60	489	285	1012	1846
1994	624	577	132	463	1796
1995	528	158	441	924	2051
1996	353	823	76	1202	2454
		FIRE – 17 JANUARY 1997			
1997	0	917	437	703	2057
1998	637	0	713	1215	2565
1999	411	466	368	730	1975
2000	638	830	454	1134	3056

for the same period have been shown for comparison.

From October 1997 to February 1998, pollen swabs were collected from *Tarsipes*, using the technique described by Wooller *et al.* (1984). Each animal was thoroughly sampled by rolling the gel around the muzzle as far back as the eyes, because charcoal still present from the fire tended to mask some of the pollen.

Captures of invertebrate animals were also recorded and observations made on their abundance.

Foxes *Vulpes vulpes* were controlled before and after the fire by the use of 1080 poison in eggs.

The regeneration of plants was studied using a 10 metre square quadrat, established in April 1997 in the centre of the trapping area. Growth and seedling counts of banksias were recorded at least once a year.

OBSERVATIONS AND RESULTS

During the first quarter after the fire, several small reptiles, *Ctenotus catenifer, Hemiergis peronii, Lerista microtis, Glaphyromorphus gracilipes* and one *Aprasia striolata* were encountered while restoring fence lines before trapping recommenced. Many would have survived the fire beneath the ground, as did one Bardick *Notechis curtus* in a pitfall trap closed with brush. A max-min thermometer in one pitfall trap, over which the fire passed, only recorded a maximum of 28° C, 50 cm beneath the surface.

Sticknest and bull ants, Formicidae, cockroaches *Blatta orientalis*, carab beetles, Carabidae and male Mouse Spiders *Missulena hoggii* were also regularly seen during the first and second quarters. Most sticknest ant nests were totally consumed, leaving craters 30 cm deep in the bare sand 48 hours post-fire, yet obviously many small nuclei of ants survived.

During the first winter post-fire (second and third quarters 1997), most of the traps at Site H flooded due to the raised water table (never having flooded before), so were closed with brush. This did not keep out frogs, many of which were caught.

Within the quadrat, two *Adenanthos* species (10 plants of *A. obovatus*; 34 *of A. cuneata*) grew from their lignotubers and flowered within 12 months. However 8 *Banksia quercifolia* were totally destroyed, but numerous seedlings at 5–12 leaf stage were recorded:

- 466 at ten months,
- 363 at twenty-three months,
- 159 at forty-one months (two with flowers),
- 69 at forty-seven months (30 – 40 cm high and showing vigorous new growth).

In deep sand it seems that surviving *Banksia quercifolia* seedlings may require up to four years establishing a deep root

system to reach the water table. At Site H, where the water table was nearer the surface, some seedlings attained 60 – 70 cm height with several flowers by 36 months. New growth from thicker branches of *Banksia attenuata* was evident by twelve months and flowers by the end of the second year, though later in the year than usual.

Surface coverage by regeneration was slow and estimated at 5% by the end of the second quarter, 15% by the end of the first year and still under 50% by the end of the fourth year, whereas prior to the fire, where the sword grass, *Lepidospermum* species, grew prolifically, they provided a dense thatched mat and 100% cover.

For the period 1993 to 2000, the total trapnights each quarter are presented in Table 2. The vertical arrow on subsequent charts indicates when the fire occurred. Since the fire, no trapping was carried out during two quarters, the first in 1997 immediately after the fire, and the second during the second quarter 1998. The total trapping effort per year averaged 2000 trapnights.

Total captures of the House Mouse *Mus musculus* per quarter at all sites are shown (Figure 1a).

Five species of amphibians occur in the Park and all were encountered during the second quarter (winter) after the fire. In decreasing order of abundance the five species were: *Crinia georgiana, Limnodynastes dorsalis, Heleioporus eyrei, Litoria moorei* and *L. adelaidensis*. Whereas *Crinia georgiana* is not normally considered a burrower, it could have survived beneath the ground as did the two burrowing species *Limnodynastes dorsalis* and *Heleioporus eyrei*. The two *Litoria* species have arboreal capabilities. Total frog captures per quarter are shown (Figure 1b).

Five species of small skinks that occur in the Park were all captured within twelve months of the fire. In decreasing order of abundance they were: *Hemiergis peronii, Lerista microtis, Glaphyromorphus gracilipes,, Ctenotus catenifer* and *Acritoscincus trilineatum*. Total small skink captures per quarter are shown (Figure 1c). The large Bobtail *Tiliqua rugosa*, many of which would have been killed in the acute phase, was only encountered twice, on both occasions at the wetter Site H.

Three *Notechis* species (*N. scutatus, N. curtus, N. coronatus*) were first seen in the last quarter of 1998, almost two years after the fire.

Total captures of adult and immature Coastal Dunnart *Sminthopsis griseoventer* per quarter at all sites are shown (Figures 2a; 2b). Immature dunnarts were only found in the first and fourth quarters. An unexpected dasyurid, an adult male Mardo *Antechinus flavipes*, was trapped in the second quarter of 2000 at Site G, where this species had not been recorded before. The few previous Mardos in the Torndirrup National Park had

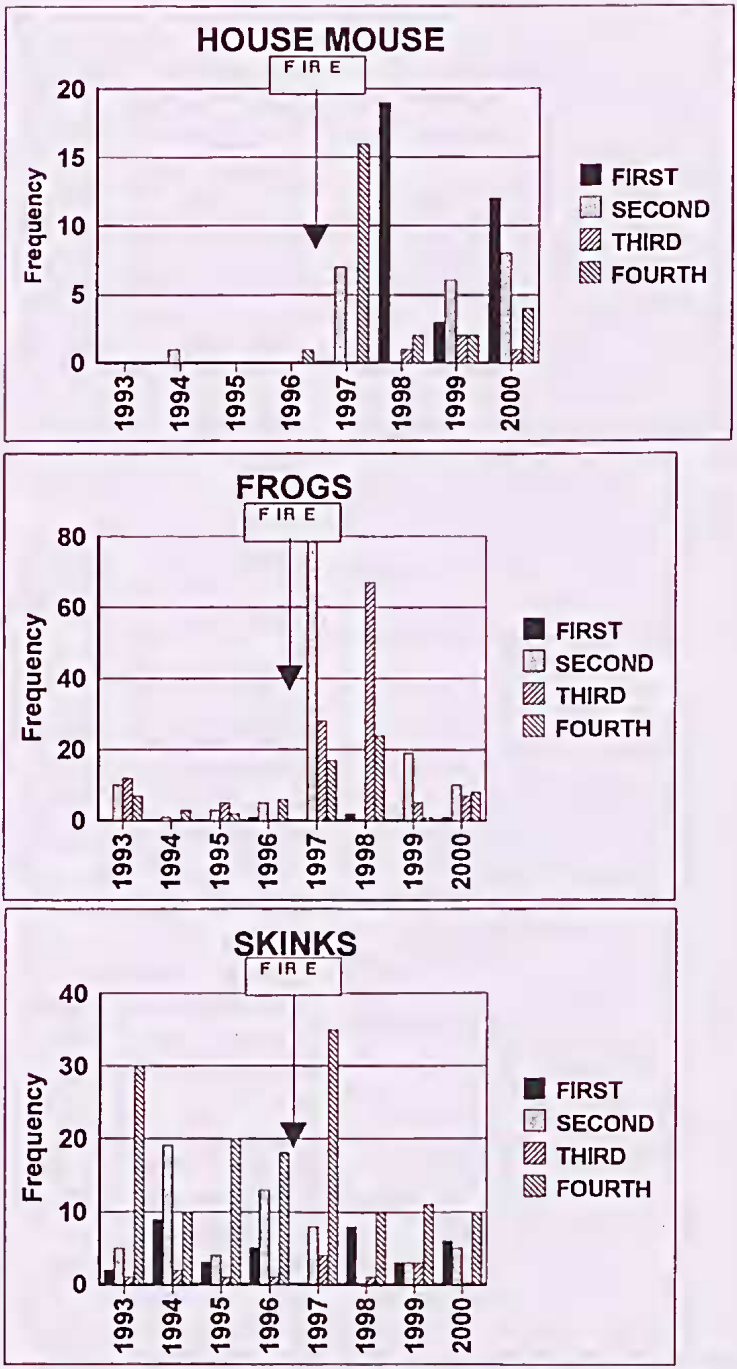

Figure 1. Showing total catches per quarter (1993–2000) of: a. House Mouse, b. Frogs (five species), c. Small skinks (five species).

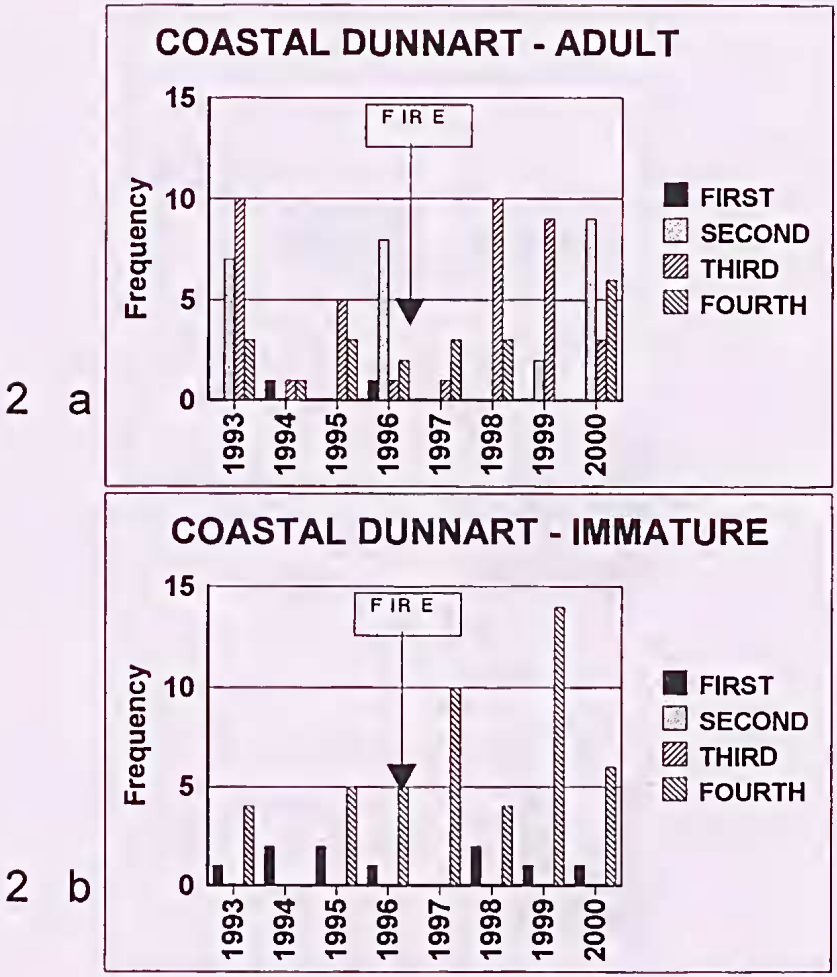

Figure 2. Showing total catches for each quarter (1993–2000) of Coastal Dunnart, showing adults and immatures.

been trapped in relict Karri forest.

Only seven Bushrats *Rattus fuscipes* were trapped in the first two years after the fire.

The first young Southern Brown Bandicoot *Isoodon obesulus* was not captured until 36 months after the fire at Site A, near the fire edge. Since only young bandicoots are caught in pitfall traps, the adults capable of jumping out, this would suggest that little breeding had occurred until three years after the fire.

The capture rates per quarter of Honey Possums over eight years at two sites (G & J) well in from

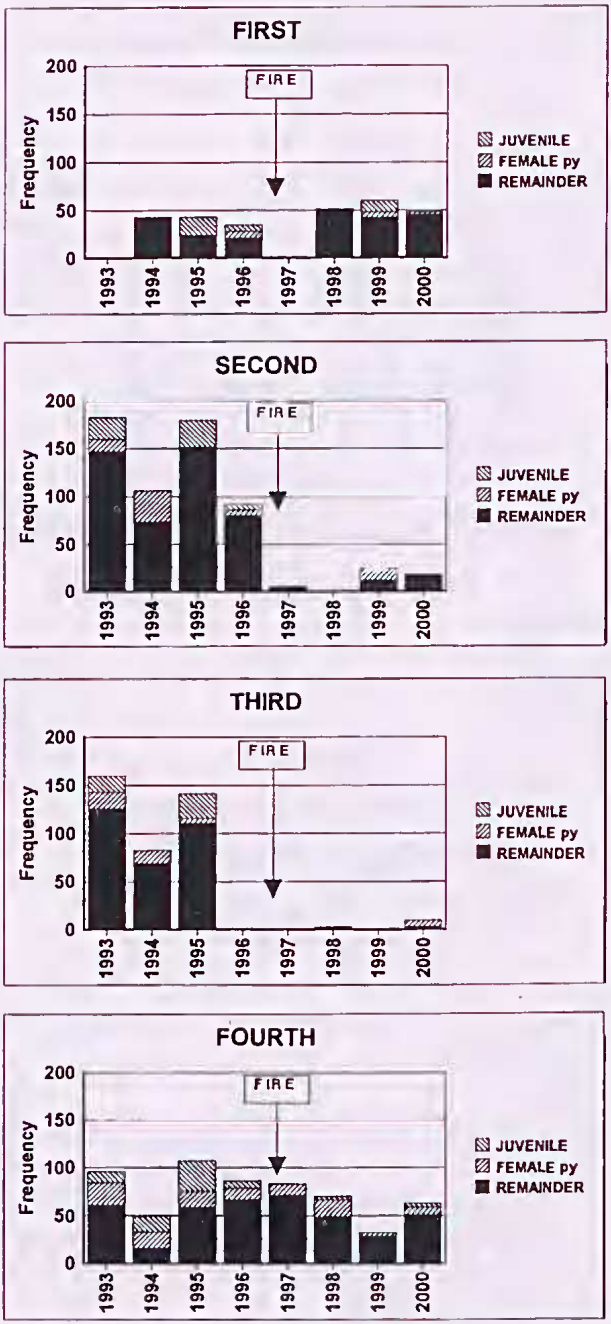

Figure 3. Showing capture rate per 1000 trapnights of Honey Possum (Sites G and J only) for each quarter (1993–2000), showing juveniles, females with pouched young (py) and the remainder (adult males and females).

the fire edge, are illustrated (Figure 3).

Pollen examination revealed abundant amorphous charcoal in many samples, yet stained pollen grains showed up clearly. Only light loads of pollen were found in 60% of the total samples taken. Eighteen of twenty-seven samples from sites G and J, well within the fire edge, had light loads of *Banksia* and *Adenanthos* pollens. No other pollens could be detected, although other species (Southern Cross *Xanthosia rotundifolia*, Drumsticks *Dasypogon bromeliifolius* and Lanolin Bush *Franklandia fucifolia*) were flowering.

DISCUSSION

The Bardick, found two days after the fire alive and uninjured beside a pit trap, probably fell victim to the many predatory or scavenging birds, including Australian Ravens, Australian Magpies, Laughing Kookaburras and Grey Currawongs which were encountered quartering the burnt area, or perhaps to the Rosenberg's Monitor which survived in its burrow beneath a charred bush not far away.

The fierce fire eliminated all but those species of vertebrate and invertebrate fauna with fossorial habits, yet the progression of recovery by recolonization and regeneration follows the predictions of Friend (1993).

During the acute impact phase, the increase in numbers of House Mice, a post-disturbance opportunist, was particularly evident in the second and fourth quarters of the first year, though not one was caught during the wet and cold third quarter. Their numbers rose to a peak in the first quarter of the second year, then declined. This is a well-recognised response.

The abundance of amphibians seen soon after the fire, particularly noticeable in the wetter, colder second and third quarters of each year suggested that their survival and recovery may have been enhanced by three factors, their ability to burrow, plentiful invertebrate food and the absence of predators, particularly snakes.

The numbers of smaller skink species reached their peak during the warmer fourth quarter of the first year, although ground cover was still scant and in spite of some possible losses from predation. There appeared to be no long-term impact on numbers, as already shown by Bamford (1995).

By the second year numbers of Coastal Dunnarts had returned to their pre-fire levels, because this species is a monoestrus spring breeder (Bamford 1986; Smith 1990), free-living young appearing consistently in mid-December each year. Young present in the last quarter of the first and second years after fire confirm that breeding had been successful. With the abundance

of skinks and invertebrate food immediately after the fire, dasyurid numbers could be expected to recover rapidly, once protective vegetation cover became established, yet some would also survive in old sticknest ant nests or burrows.

The few adult Honey Possums captured in good condition 400 – 600 metres inside the burnt area during the first six months were apparently pioneering colonists, yet not one was trapped or recaptured in the colder and wetter third quarter, though several were captured in the last quarter of the first year. By two years post-fire, Honey Possum capture rates were within the range of pre-fire capture rates in lst and 4th quarters but not during the winter, suggesting that they were making seasonal use of the burnt area yet had some reproductive capacity to recolonize, provided regeneration of some nectar-producing plants, notably *Adenanthos* species, had occurred as has been reported elsewhere (Bamford 1986).

During the second and third quarters (Figure 3) their recolonization was impaired by the absence of flowers on the Oak-leafed Banksia seedlings. From previous pollen swabbing carried out during the pre-fire period, this banksia was shown to be their preferred source of food during the winter when it flowers. Regenerated seedlings in deep sand take at least five years before there is much flower, a situation that is likely to be exacerbated if this obligate-seeding species is threatened by other factors, like Dieback, which may jeopardise its recovery.

A possible solution, which would benefit not only the long-term survival of this banksia but also the Honey Possum, is the patch burning *at an appropriate time of year* of small areas of this type of banksia heath to encourage regeneration from seed.

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